Improvements to Sweeping as a Volume Mesh Generation Algorithm

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1. Objectives

The objective is to improve the overall sweeping algorithm by improving specific important pieces, demonstrating their impacts in an united implementation.

3. Pipeline of Sweeping

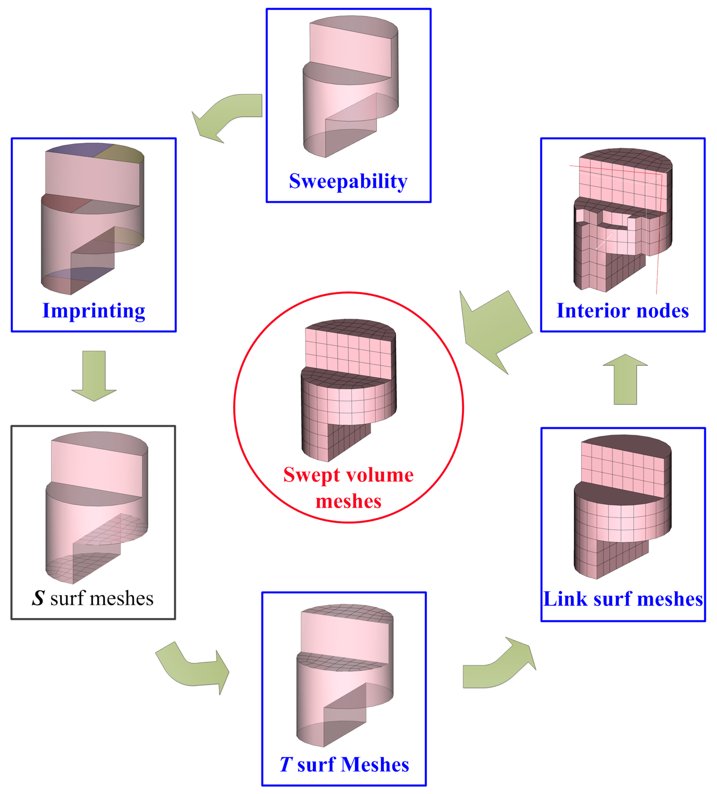

Figure 5: An example of our multi-sweeping pipeline

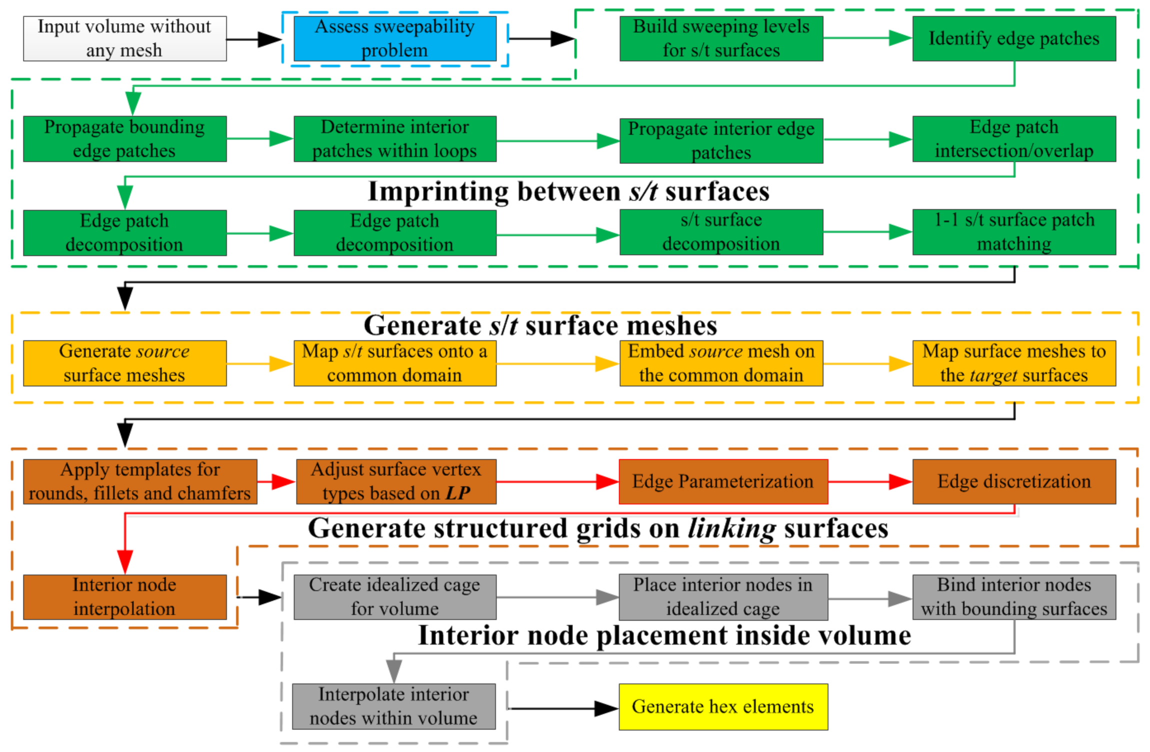

Figure 6: Pipeline of our multi-sweeping approach

2. Introduction

Extrusion of 2D meshes into a general third dimension is called "sweeping", which consists of four main steps: (a) generate surface meshes over the *source* surfaces; (b) mapping of *source* surface meshes onto the *target* surfaces; (c) generate structured meshes on the *linking* surfaces; (d) place interior nodes inside volumes and generate volume elements. There are three invariants of sweeping from the point of number of s/t surfaces, namely, One-to-One (**1-1**), Many-to-One (***M*-1**) and Many-to-Many (***M*-*N***).

4. Edge Patch Imprinting

An edge patch imprinting based on cage-based morphing for multi-sweeping problems has been developed, which is used to resolve conflicts of vertices and edges between s/t surfaces(embed s vertices/edges onto the t surfaces. This results in: each s surface patch is paired with exactly one t patch after imprinting. mesh and vice versa).

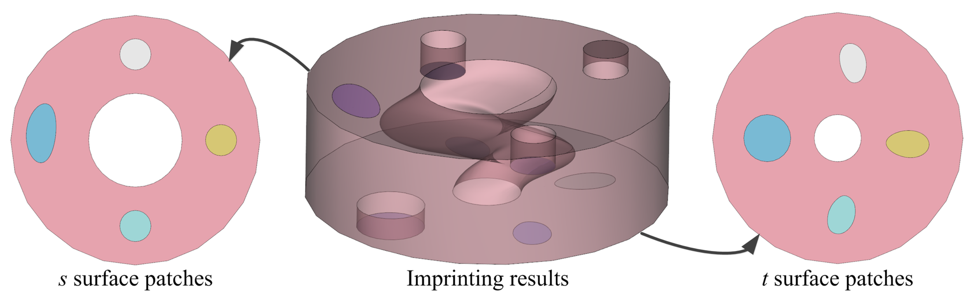

Figure 7: Edge patch imprinting between s/t surfaces

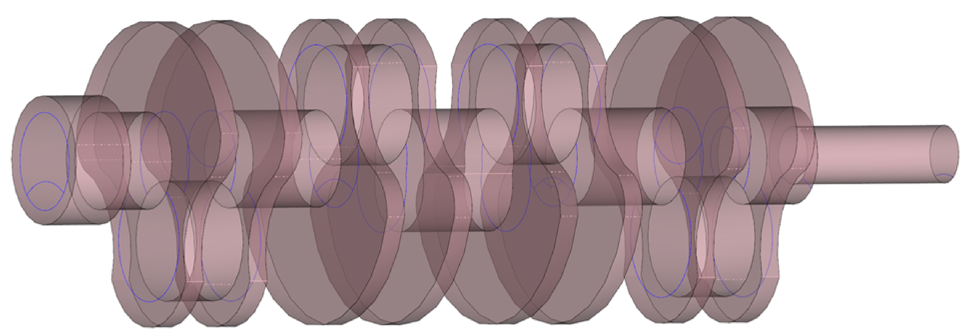

Figure 8: Crankshaft

5. Surface Mesh Mapping

Harmonic mapping is used to embed s meshes onto t surface: first map both s/t surface faceting onto the common domain and then s meshes are mapped onto t surface through the common domain.

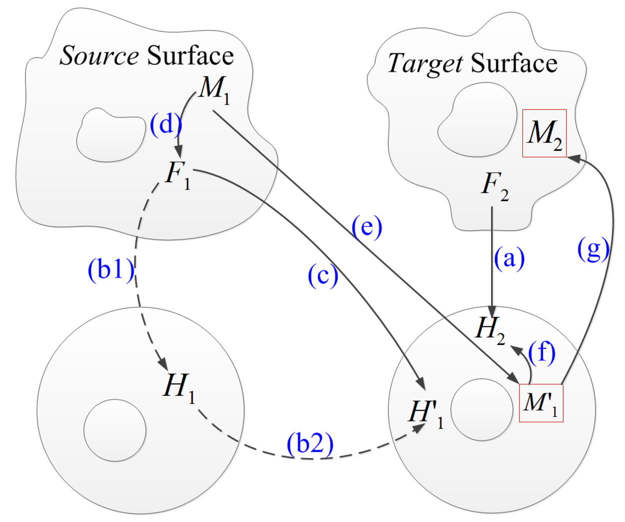

Figure 1: Roadmap of mapping s mesh onto t surface

7. Interior Node Placement

A global interior node placement algorithm based on cage-based method has been developed, consisting of 4 main steps: idealized cage creation, interior node placement inside idealized model, binding of boundary nodes with interior nodes (location of interior nodes is a function of boundary surface mesh nodes) and interior node placement inside physical models.

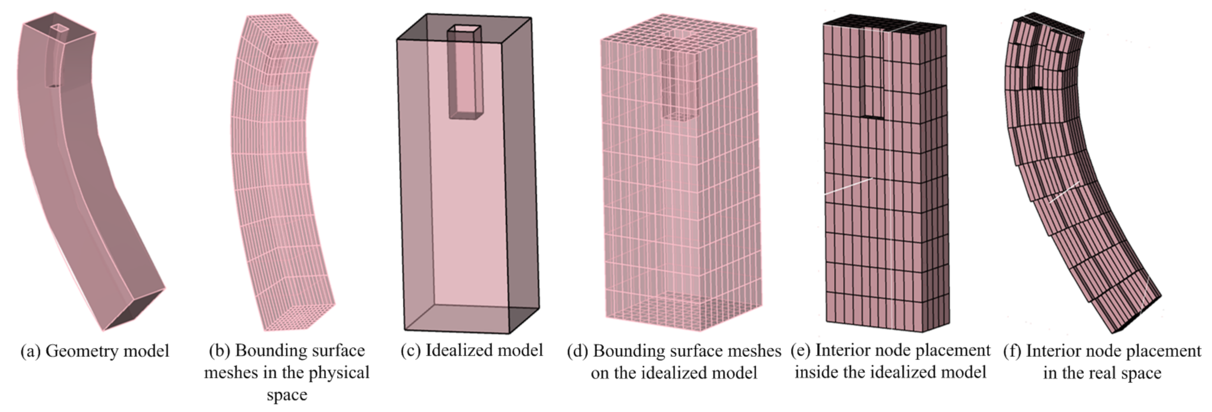

Figure 3: Pipeline of placing inner nodes

6. Submapping

Corners during submapping has been assigned based on a combination of templates (fillets, chamfers, rounds and concentric rings) and the optimization approach (guarantee the $4-4g$ submapping constraint).

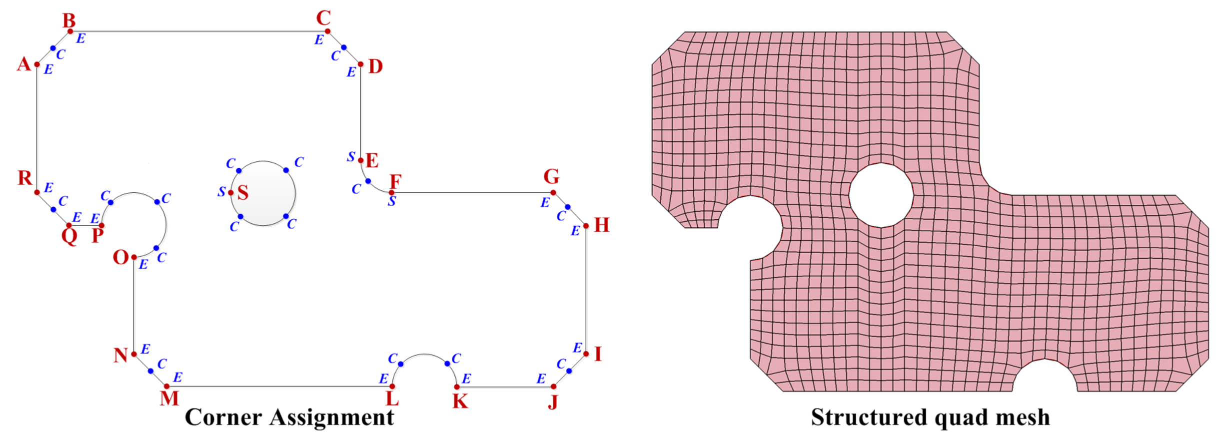

Figure 2: An example of corner assignment

8. Examples and Conclusion

The overall sweeping algorithm is improved by improving specific important pieces, demonstrated their impacts in an united implementation.

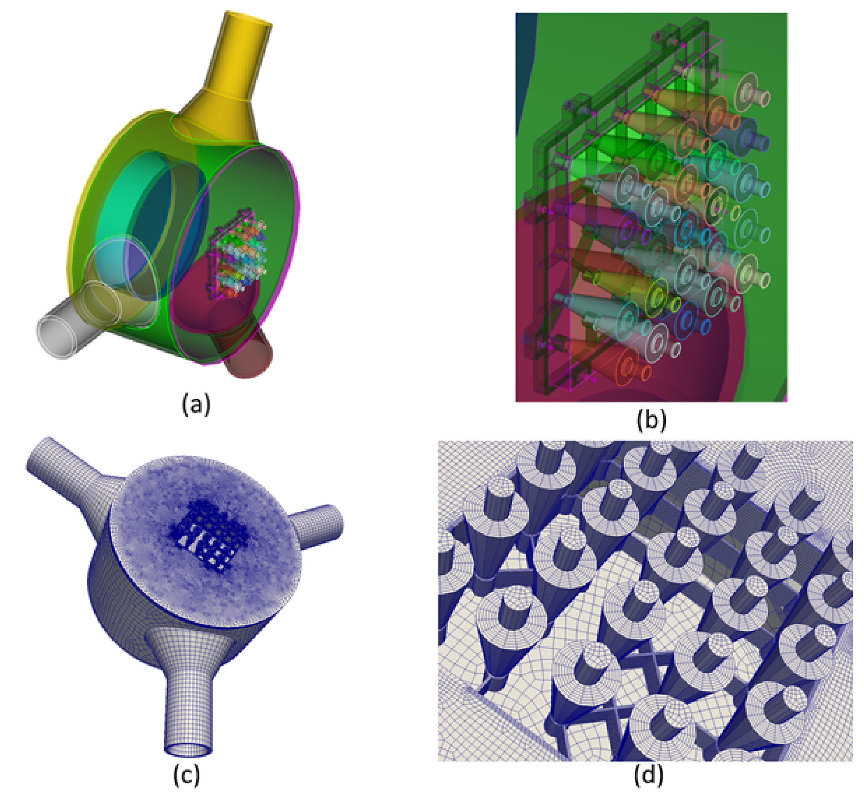

Figure 4: Sweeping for Inlet reactor model

References

[1] S. Cai and T. J. Tautges. Surface mesh generation based on imprinting of s-t edge patches. *Procedia Engineering*, 82:325–337, 2014.

[2] S. Cai and T. J. Tautges. Robust one-to-one sweeping with harmonic st mappings and cages. *Procedings of the 22nd International Meshing Roundtable*, pages 1–18, 2013.

[3] S. Cai and T. J. Tautges. Optimizing corner assignment of submap surfaces. *Procedings of the 24nd International Meshing Roundtable*, 2015.

Future Research

- Idealized model creation.
- Incorporate geometric constraints in the sweepability problem.
- Interior node interpolation on curved surfaces by submapping.
- Parallel meshing: chains of linking surfaces, mesh mapping between s/t surfaces, interior node interpolation inside volumes.